USB Breakfast Seminar Series
2011

Welcome

- **Introduction – Microchip USB Solutions**
  - Firmware (Microchip Application Library)
  - Hardware (Microcontrollers, Demoboards)
  - Demo Software, PC Software
- **Q+A based on your Design Needs**
- **Live Demos, Programming**

- **Coffee and Biscuits**

Universal Serial Bus (USB)

- **USB started as a standard for connecting peripherals (such as mice, keyboards) to PCs**

- **It's become the standard for connecting personal devices (iPods, printers) to PCs and other electronic equipment and to each other**

- **It offers:**
  - Diverse Applications
  - Ease of Use and Simple interface
  - Speed for the end user
  - Accommodate different applications simultaneously
  - Low cost solution
  - Includes power bus for peripherals in connector

USB is really keeping up to its name and is truly becoming more Universal in its applications

Classification of USB devices

- **USB Device/Peripheral**
  - Uses USB to connect itself to the main Host
  - Ex. Keyboard, Mouse

- **USB Host**
  - Master in the transaction and can initiate the data flow
  - Ex. PC, Thumb Drive reader
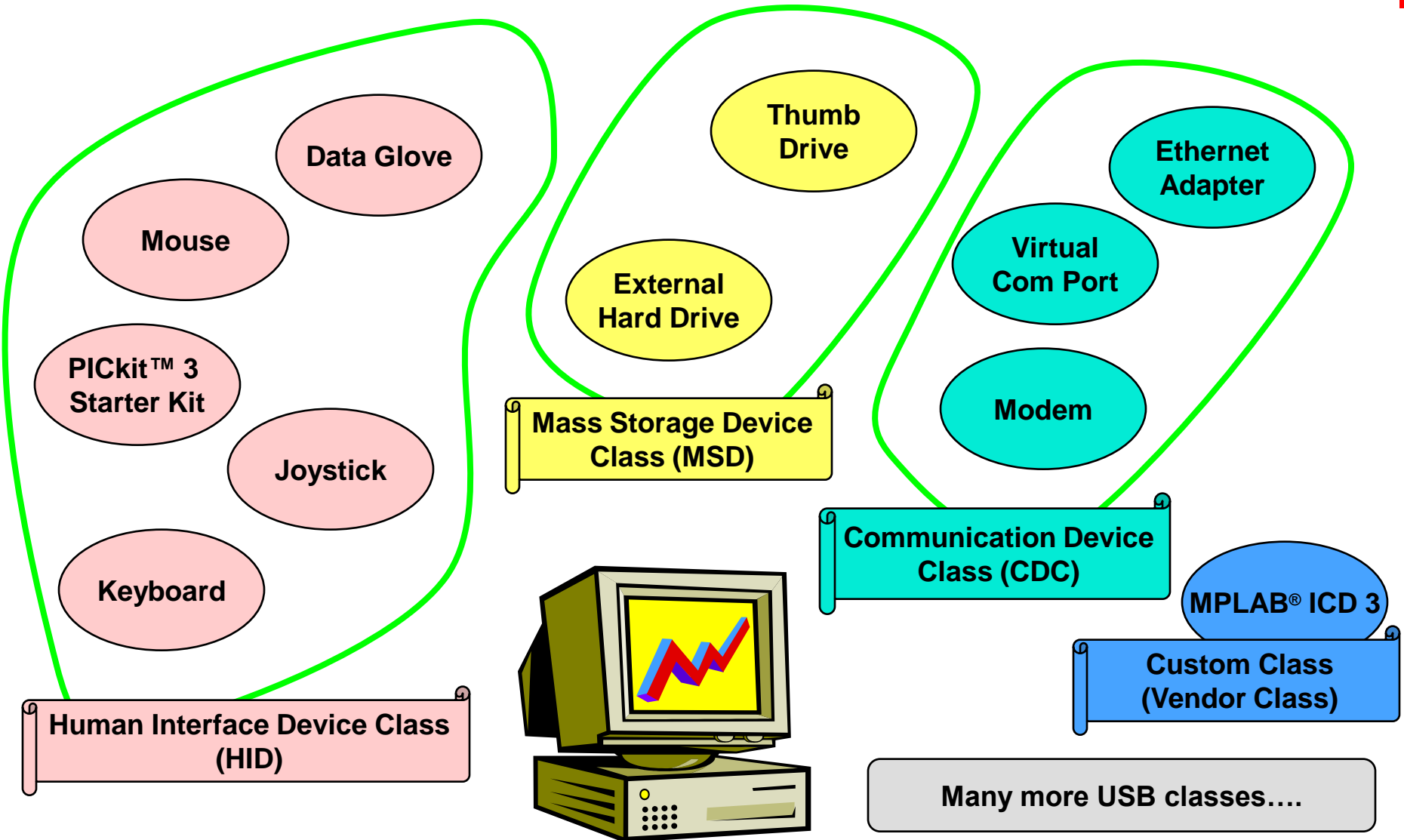
- **USB On The Go (OTG)**
  - Host and Peripheral, both in one (Dual role devices)
  - In absence of PC, device can be host and initiate communication
  - Ex. Some Printers, Advanced Cameras, Handheld Scanners

**Microchip offers solutions which can fit your design needs,
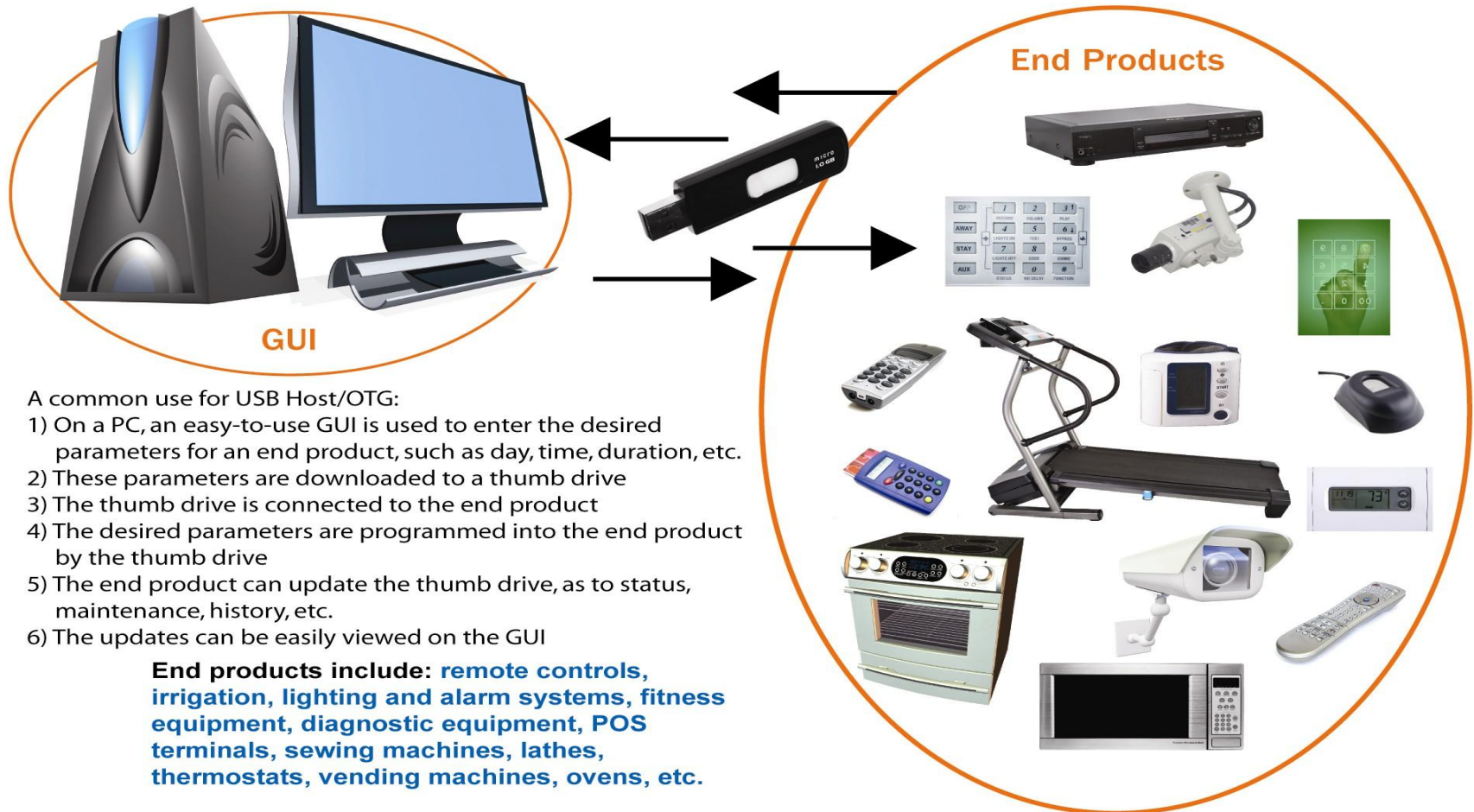Be it USB peripheral device, Embedded Host or USB OTG**

USB Peripheral Device

- **Responds to Host, cannot initiate transactions**
- **Requires drivers to be recognized by the Host**
- **Hardware/Firmware to respond to Host**
- **Microchip's PIC® MCUs are used in USB Peripheral Devices**

USB Peripheral Device Classes

MICROCHIP

Farnell element14

Data Glove

Mouse

PICkit™ 3 Starter Kit

Joystick

Keyboard

Human Interface Device Class (HID)

Thumb Drive

External Hard Drive

Mass Storage Device Class (MSD)

Ethernet Adapter

Virtual Com Port

Modem

Communication Device Class (CDC)

MPLAB® ICD 3

Custom Class (Vendor Class)

Many more USB classes….

Thumb Drive Applications

End Products

GUI

A common use for USB Host/OTG:
1) On a PC, an easy-to-use GUI is used to enter the desired parameters for an end product, such as day, time, duration, etc.
2) These parameters are downloaded to a thumb drive
3) The thumb drive is connected to the end product
4) The desired parameters are programmed into the end product by the thumb drive
5) The end product can update the thumb drive, as to status, maintenance, history, etc.
6) The updates can be easily viewed on the GUI

End products include: remote controls, irrigation, lighting and alarm systems, fitness equipment, diagnostic equipment, POS terminals, sewing machines, lathes, thermostats, vending machines, ovens, etc.

Microchip Advantage

- **Solutions span 8-, 16- and 32-bit PIC® MCUs**

- **50+ MCUs in USB portfolio**

- **Packages from 20 pins to 121 pins**

- **Easy-to-use and upgradeable products for embedded designs**

- **Sample code for complex USB applications**

- **Full Speed USB 2.0 capable 8-bit products**

- **Full Speed USB 2.0 (OTG) and embedded host USB options in 16 and 32-bit families**

USB Microcontrollers

Feature	PIC18F Family	PIC24FJ Family	PIC32MX Family
Core	8-bit	16-bit	32-bit
USB	USB 2.0 Full-Speed device only	USB 2.0 Full-Speed device, Embedded host, OTG	USB 2.0 Full-Speed device, Embedded host, OTG
Performance	12 MIPS	16 MIPS	Up to 80 MIPS
Flash	8KB to 128KB	32KB to 256KB	32KB to 512KB
RAM	512 to 3904 Bytes	16KB to 96KB	8KB to 128KB
m-Touch support / cap touch channels	Up to 13 channels	Up to 16 channels	16 channels
UARTs	Up to 2	up to 4	Up to 6
SPI	Up to 2	up to 3	Up to 4
I2C	Up to 2	up to 3	Up to 5
Peripheral pin select	Available	Yes	Yes
ADC	10-bit up to 13 channel	10-bit up 16 channels	10-bit, 16 channels
RTCC	Yes, software	Yes	Yes
Parallel Master Port	Available	Yes	Yes
Analog comparators	2	3	2
Free software stacks	Free USB software stacks and class drivers are available for all Microchip PIC microcontrollers that feature USB. They are also all compatible with the same integrated development environment		
Free class drivers			
Scalable development environment			
Power features	☆ Sleep, Deep Sleep	☆ Sleep, Deep Sleep	Sleep
Packages	20 to 80 pins	28 to 100 pins	64 to 121 pins

☆ These products also feature nanowatt eXtreme Low Power

9

Featured Development Tools

$59.98

Low Pin Count USB Development Kit
Part Number: DV164126 (1690680)
Use with new 20-pin PIC18F USB MCUs –
Quickly implement common USB functions:
RS232 to Serial, Keyboard/Mouse, etc…

Included Today

MPLAB Starter Kit for PIC24F
Part Number: DM240011 (1605296)

Use with PIC24F Family - The Demo Kit provides
all of the hardware and software needed to
demonstrate and develop a complete USB device
and host solution (OTG)

$45

**PIC18F46J50 Full Speed
USB Plug-In Module**
Part Number: MA180024 (1706356)
*(Can be used stand alone or use with
PICDEM HPC Explorer Board)*

Use with any of the PIC18F46J50 family microcontrollers

MCP2200 – USB to UART converter

- **UART to USB 2.0 Protocol Converter**
  - USB 2.0 Compliant (certified) – Full Speed
  - Allows USB Host to communicate to a UART peripheral
  - Configurable, with 8 general purpose I/O pins
  - Small Packaging: SOIC, SSOP, 5x5 QFN
- **RS232 to USB evaluation board**
  - Fully powered from USB
  - Completely plug and play
  - Part number: MCP2200EV-VCP (1798095)
- **Target Applications**
  - Serial to USB Converters
  - Interfacing to legacy equipment
  - Adding USB to existing applications

For Additional Information

For additional information on USB and PIC products w/ USB visit

www.microchip.com/USB

One-Stop-Shop for:
List of MCUs with USB
Free USB Drivers & Firmware
App Notes
Development Tools
Documentation
USB Device Compliance Testing IDs

Demo Examples

Regional Training Center
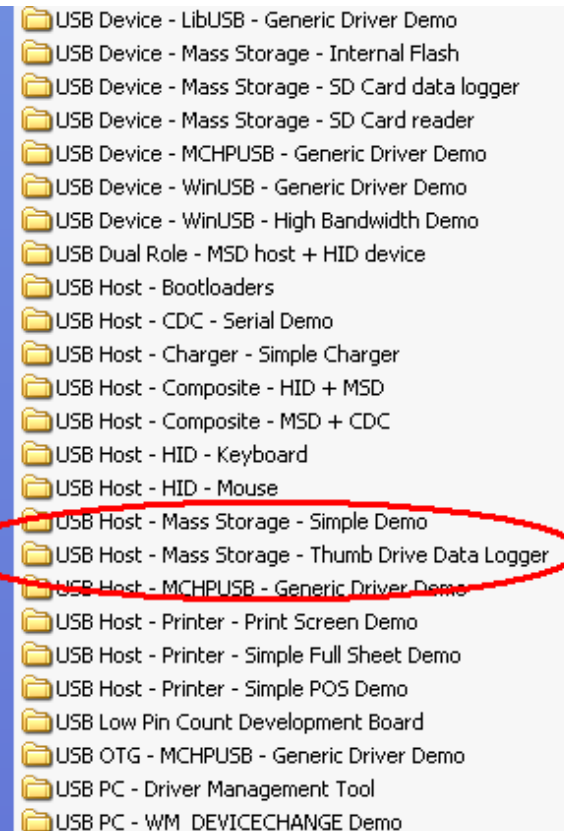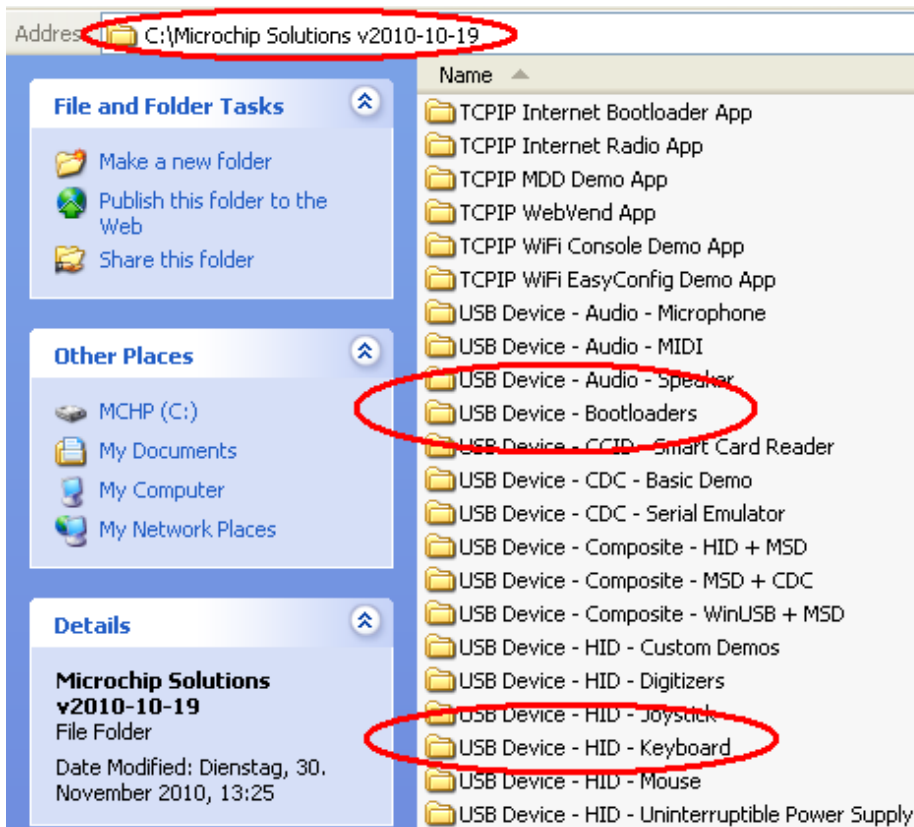
- **35 RTCs Worldwide**
- **In-depth Technical Training**
- **Interactive Classes**
- **Hands-on Workshops**
- **USB, Ethernet, Touch Sensing, CAN etc.**
- **Tools and Equipment**
- **Local Language Support**
- **On-Site training available (min 6 attendees)**
- **www.microchip.com/RTC**

2008-2009 Course Catalog

Regional Training Center Course Catalog

HIF 2131: Sviluppare applicazioni usando la libreria grafica di Microchip ✉

Type:	Hands-On
Language:	Italian / Italiano
Date:	Thursday, March 04, 2010 9:15 AM - Thursday, March 04, 2010 6:00 PM
Time:	9:00 AM - 9:15 AM Arrival/Check In 9:15 AM - 6:00 PM Presentation:
Cost:	Ad ogni iscritto sara' consegnato un buono sconto del 20% sui sistemi di sviluppo Microchip. **The prices shown for this class don't include tax. Local taxes will be added upon check out.** Basic Seminar - 150.00 EUR To add this class to the cart and continue shopping and checkout later, please click: [Add this Class to Selected Classes] To complete the registration to this class please click here: [Complete Registration] Pranzo incluso.
Where:	*(All Upcoming Classes Scheduled At This Venue)* Padova Map Via Lisbona 10 35127 Padova Italy

Abstract : Show/Hide

Questa classe mostra come sfruttare le capacità della libreria grafica sviluppata da Microchip, così da ridurre i tempi dello sviluppo di interfacce grafiche che sfruttano le varie tecnologie dei display LCD e l'utilizzo di diversi ingressi. Durante la parte pratica di questo corso, utilizzerete la libreria grafica di Microchip su un Explorer 16 collegata ad una Graphics PICtail Plus Daughter board (AC164127) per implementare un'interfaccia grafica che usa il Touch Screen QVGA della PICtail. La classe è presentata usando il PIC24F fornito con la Explorer 16, ma gli stessi concetti si possono applicare utilizzando un Plug-In-Module del PIC32 (MA320001).

Recommended Prior Knowledge : (While attendance at the class(es) listed below is not mandatory, it is recommended that attendees in this class have the knowledge listed below. This will ensure the best possible learning experience for all as time constraints will not allow us to review material outside the scope of this class.)

Programmazione in linguaggio C dei microcontrollori Microchip PIC24 o PIC32. Classi suggerite: MCU3122

Contact:

If you have additional questions regarding this class, you can contact:
Giacomo Colombo
+39 0331 742642
giacomo.colombo@microchip.com

RTC Curriculums

- **Bus Communication and Networking**

COM 3101   Introduction to Full-Speed USB

COM 3201   Designing a Custom USB Peripheral Application

COM 3202   Designing a USB Embedded Host Application

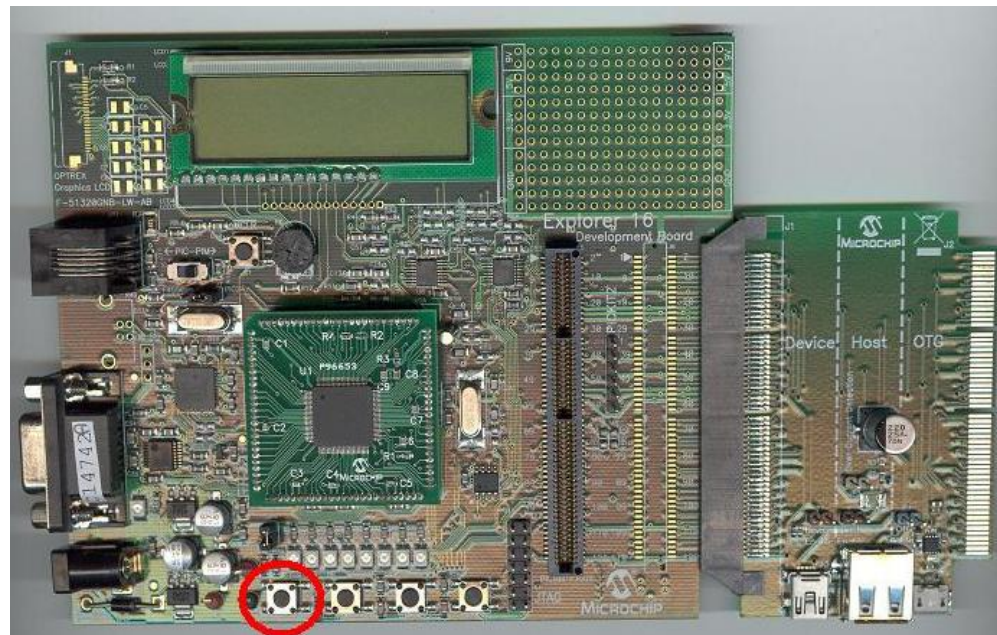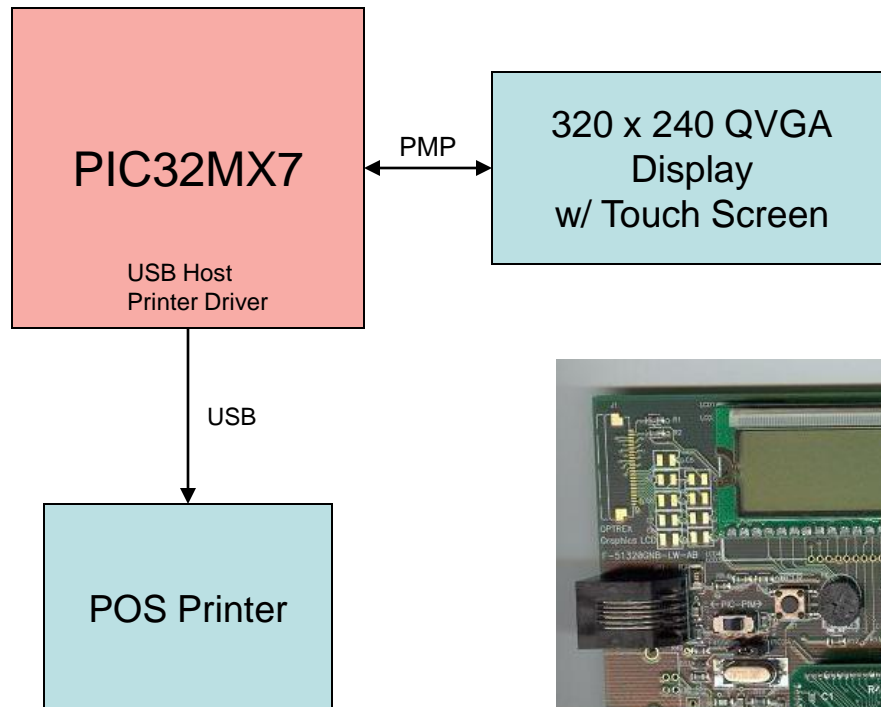# Annual Masters Conference

- **Masters 2011 in Arizona, Phoenix**

- **Provides training classes at all technical levels**

- **6 different USB classes including also handson training and programming**

- **www.microchip.com/usmasters**

Demos

- **HID Joystick**
- **MCP2200 Demo**
- **Serial to USB Emulator**
- **Thumb Drive Data Logger**
- **Autorun Demo**
- **Scanner Demo**
- **Printer Demo**
- **Composite Device Demo CDC + MSD**
- **Dual Role Device**
- **Wireless Miwi USB**
- **USB Device Bootloader**
- **USB Host Bootloader**
- **High Bandwidth Data Transfer Demo**

Printer Demo

- **Explorer16 and Graphics is used with a PIC32MX7 device as a USB Host**

- **Via a graphics display pictures can be drawn and printed out via the USB printer**

- **The PIC32 is handling the graphics stack and USB Host protocol including the printer driver**

Printer Demo

```
┌─────────────────┐              ┌──────────────────────┐
│                 │     PMP      │   320 x 240 QVGA     │
│    PIC32MX7     │ ◄──────────► │      Display         │
│                 │              │   w/ Touch Screen    │
│  USB Host       │              └──────────────────────┘
│  Printer Driver │
└─────────────────┘
        │
        │ USB
        ▼
┌─────────────────┐
│                 │
│   POS Printer   │
│                 │
└─────────────────┘
```


BACK

Scanner Demo

- **In this demo the PIC® is getting scanned data from a barcode scanner and displaying the data on the LCD display**

- **The interface used in this scanner is the Human Interface Device HID Class**

- **The demo is using the Explorer16 demoboard and the USB PICtail™ PIM plus a barcode scanner from Farnell**

Scanner Demo

Scanned Text

MSD + CDC Demo
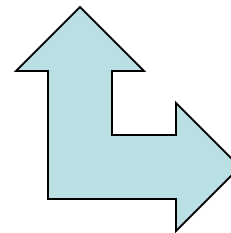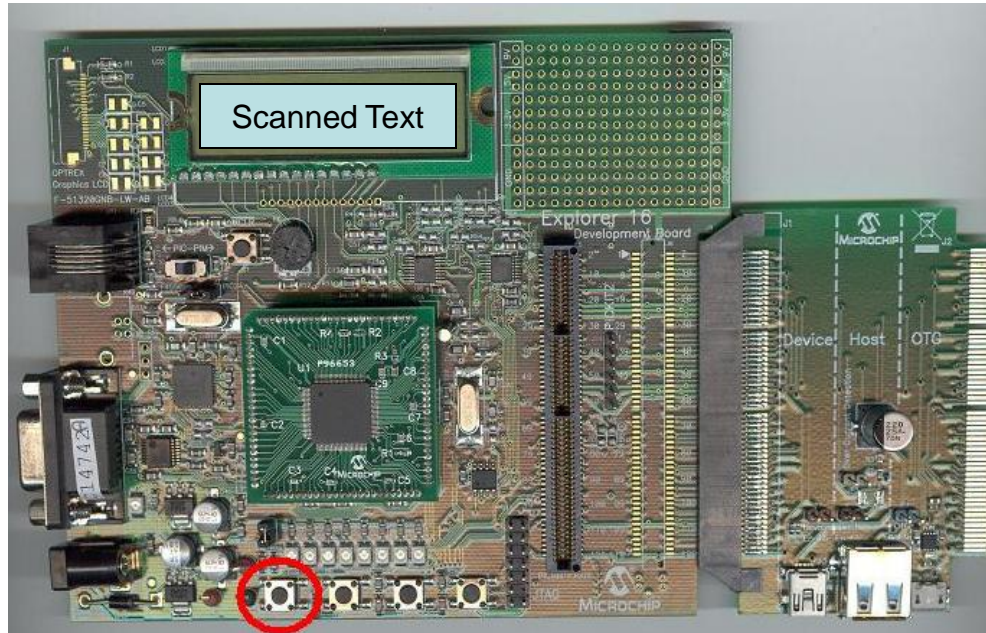
- This demo allows the PIC18 to act both as MSD and CDC at the same time, in form of a composite USB device.

  - MSD: an extra storage device connected to the PC (like a thumb drive)

  - CDC: a "serial" device which echoes back the value of the character sent incremented by one. So if the user sends the character "a" via the HyperTerminal window, the microcontroller will reply with a "b".

- **PIC18F47J53 FS USB PIM Demo Board MA180029**

MSD
(Mass Storage Device)

- **To the host device, the MSD device appears similar to an external hard drive or a thumb drive.**

- **Here we store the Driver or inf File e.g. Used for the CDC installation in Windows**

CDC
(Communication Class Device)

- **Focuses on supporting connectivity to: - telecommunication services (devices that have traditionally terminated an analog or digital telephone line)**

    - medium speed networking services ("Always Connected" LAN/WAN media types).

- **Needs an inf File for enumeration at Windows and can be taken from the MSD part**

Composite CDC + MSD

PIC

MSD Class using Internal Flash and holding inf File (or Drivers, ...)

CDC Device Class

Function

User

Function

PC

1) PC opens Flash Drive (MSD)
2) Inf File can be opened
3) CDC Drive can be installed with the inf file

USB

Demo Board Picture

mini-USB

ICSP connector for program/debug
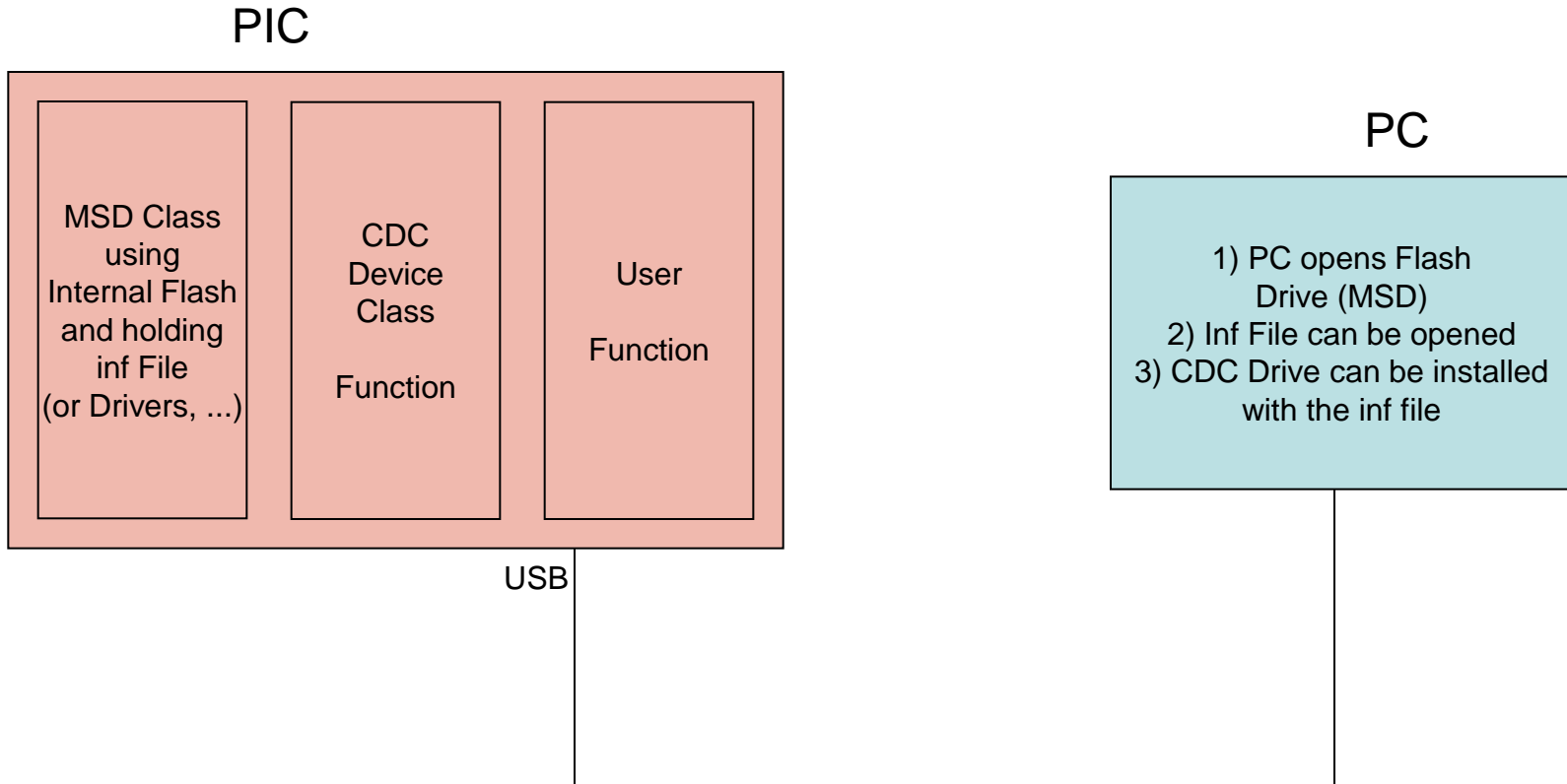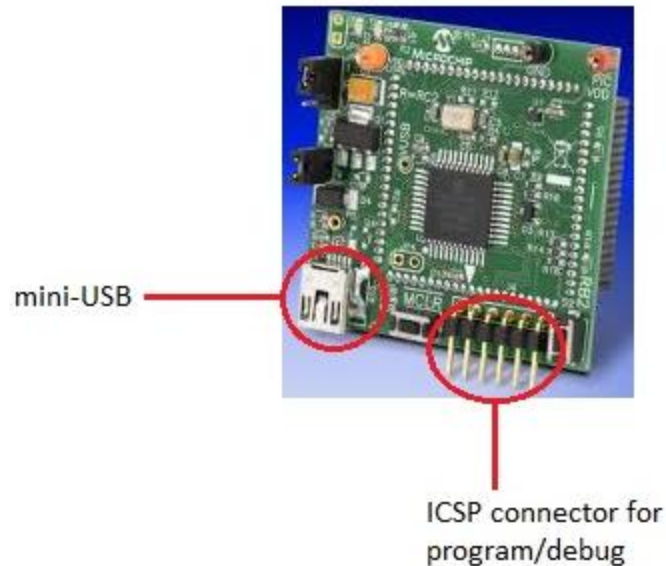
- **Can be used as a standalone demo board or with the PIC18 Explorer Board (DM183032)**

DRD Devices

- **Dual Role Devices (DRDs)**
  - 2 connectors (Standard A & Standard B/miniB)
  - Wants to be either embedded host or USB device but doesn't need to dynamically switch
- **Example: Data Logger with field update via PC**

Additional Considerations For Dual Role Devices

- **Port accessibility**
  - If more than one connector is accessible at any point of time then they need to be able to work at the same time
- **Checklists**
  - Peripheral
  - Systems

DRD Example Circuit

DRD demo
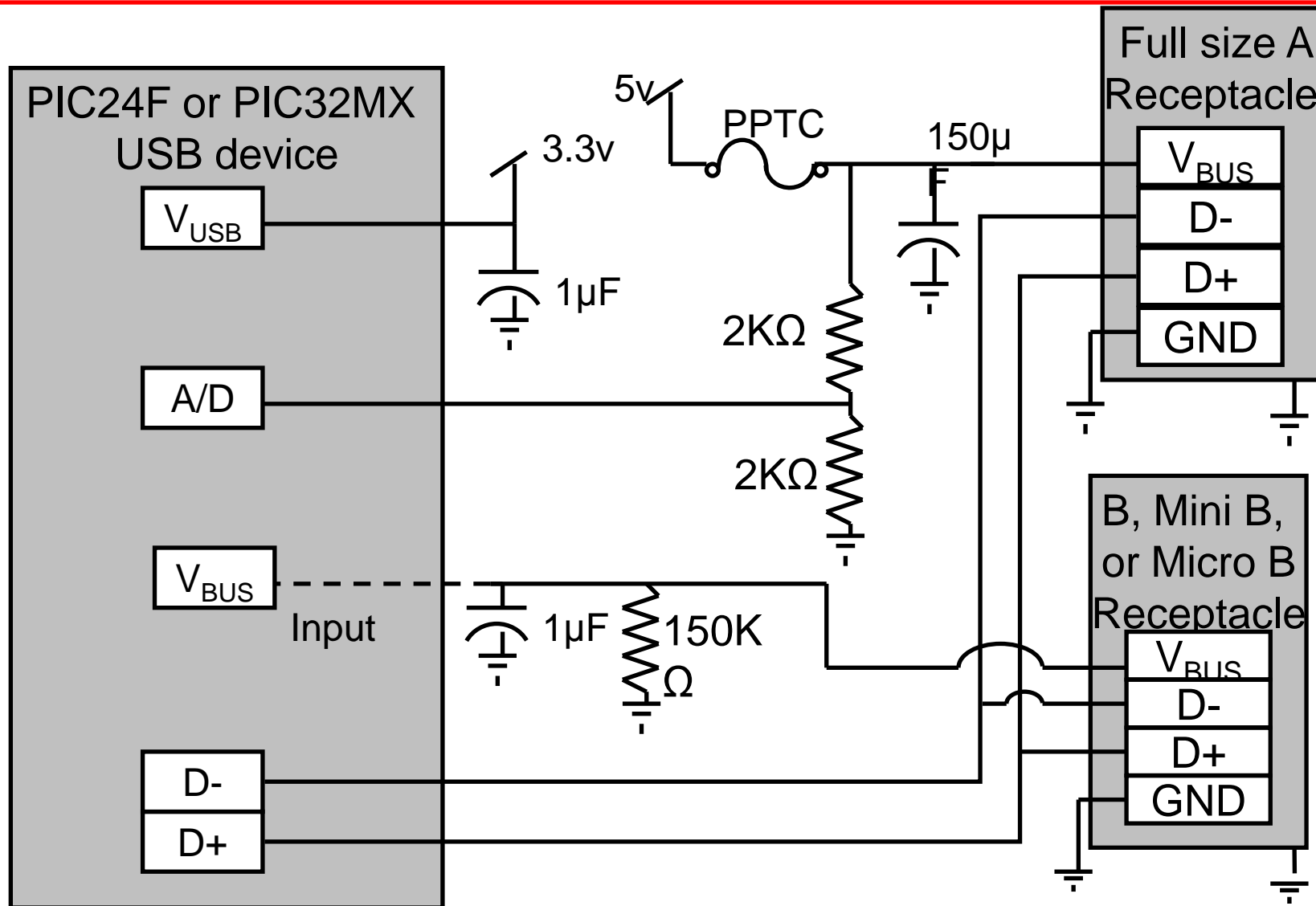
- **In this demo the PIC24 acts like a Device (HID) or a Host (MSD)**
  - When it is connected using the device port, PnP PC software communicates with the board and shows potentiometer value, button status and can toggle the LEDs
  - When a thumb drive is connected to the host port, a test file is written on to it.

- **Explorer 16 (DM240001) + USB PICtail (AC164131) + PIC24F USB PIM (MA240014)**

Demo Block diagram

MCU Specific
Plug-in Module
(PIM)

+
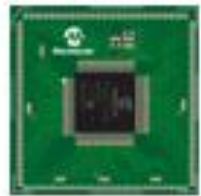
Explorer 16

+

USB PICtail Plus
Daughter Card
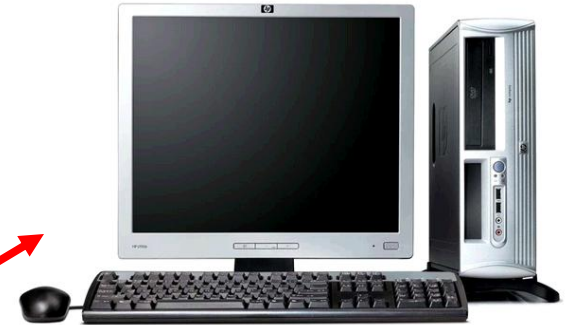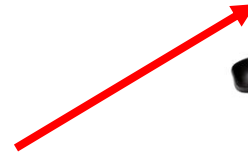
OR
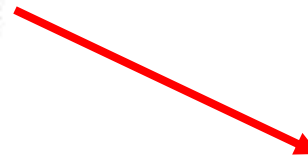
BACK

HID Device

- **The PIC$^®$ can act like a keyboard, joystick or mouse**

- **OR you could just use it to transfer data**

- **HID is a general device class for connecting many things to a PC**

HID Joystick demo

- **In this demo the PIC18 acts like a joystick**
  - Accelerometer moves the joystick
  - Potentiometer moves slider bar
  - Touch sensors act as switches and more sliders

- **PIC18F Starter Demo board DM180021**

HID Technical Details

- **No driver needed (built-in to OS)**
- **64,000 Bytes/sec transfer limit**
- **Interrupt mode transfers**
- **Descriptor tables**
  - Describe the format of the data
- **Easy to use API calls**
  - HIDTxSend
  - HIDRxReceive

Demo Block diagram

Accelerometer

BACK

Wireless MiWi™ USB Demo

- **Used Hardware**

- **PIC® PIM w/ USB e.g. PIC24FJxxxGBxxx**

- **Explorer16**

- **MRF24J40 PICtail™ Plus**

- **USB PICtail Plus**

Block Diagram

2.4 GHz
IEEE 802.15.4
Secured Encrypted
Data Transfer

PIC24 — SPI — MRF24J40 .... MRF24J40 — SPI — PIC24

USB

USB Connector

Virtual COM Port

e.g. Win PC w/ Terminal Program like Hyperterminal

USB

USB Connector

Virtual COM Port

e.g. Linux w/ Terminal Program

Setup

Communication Device Class
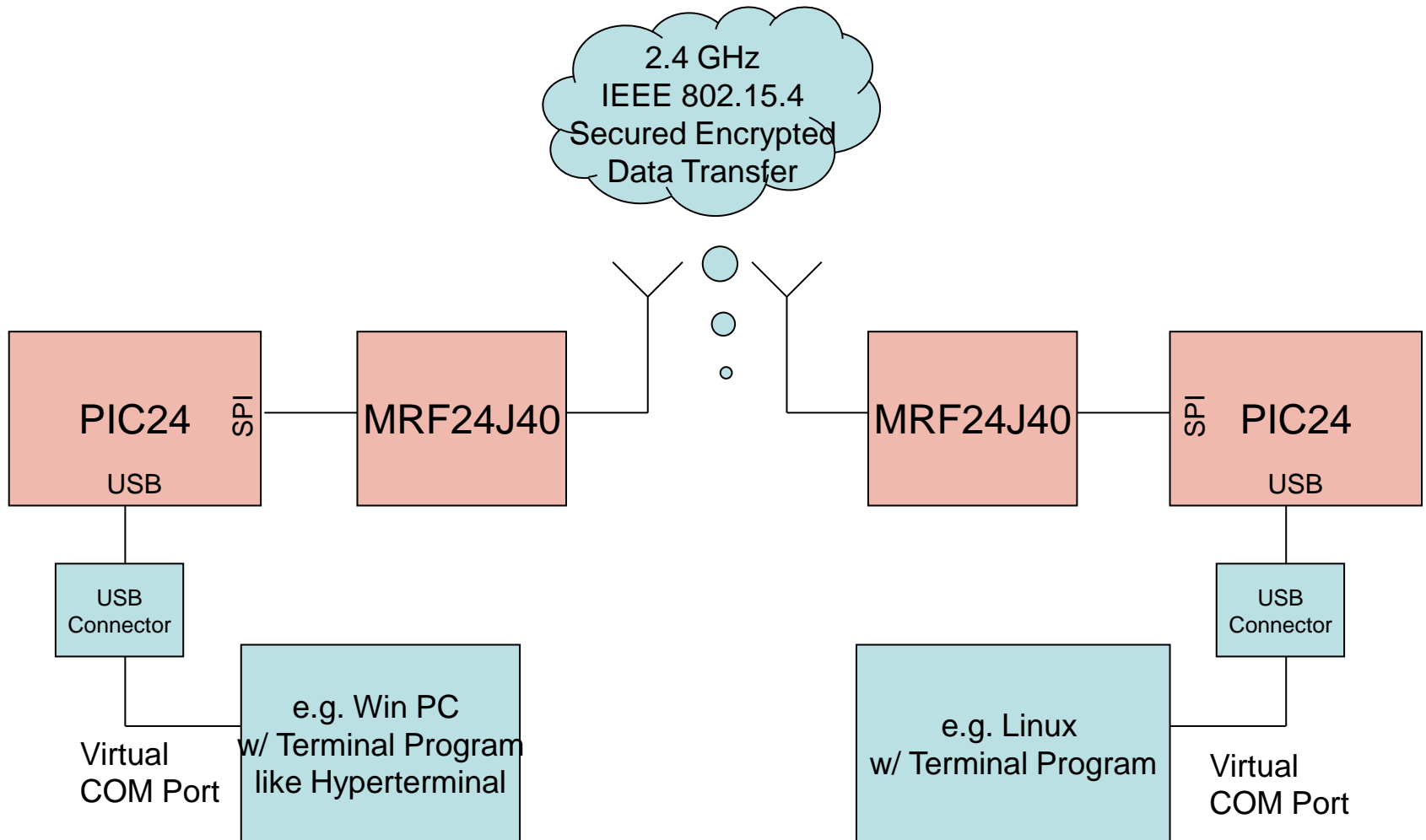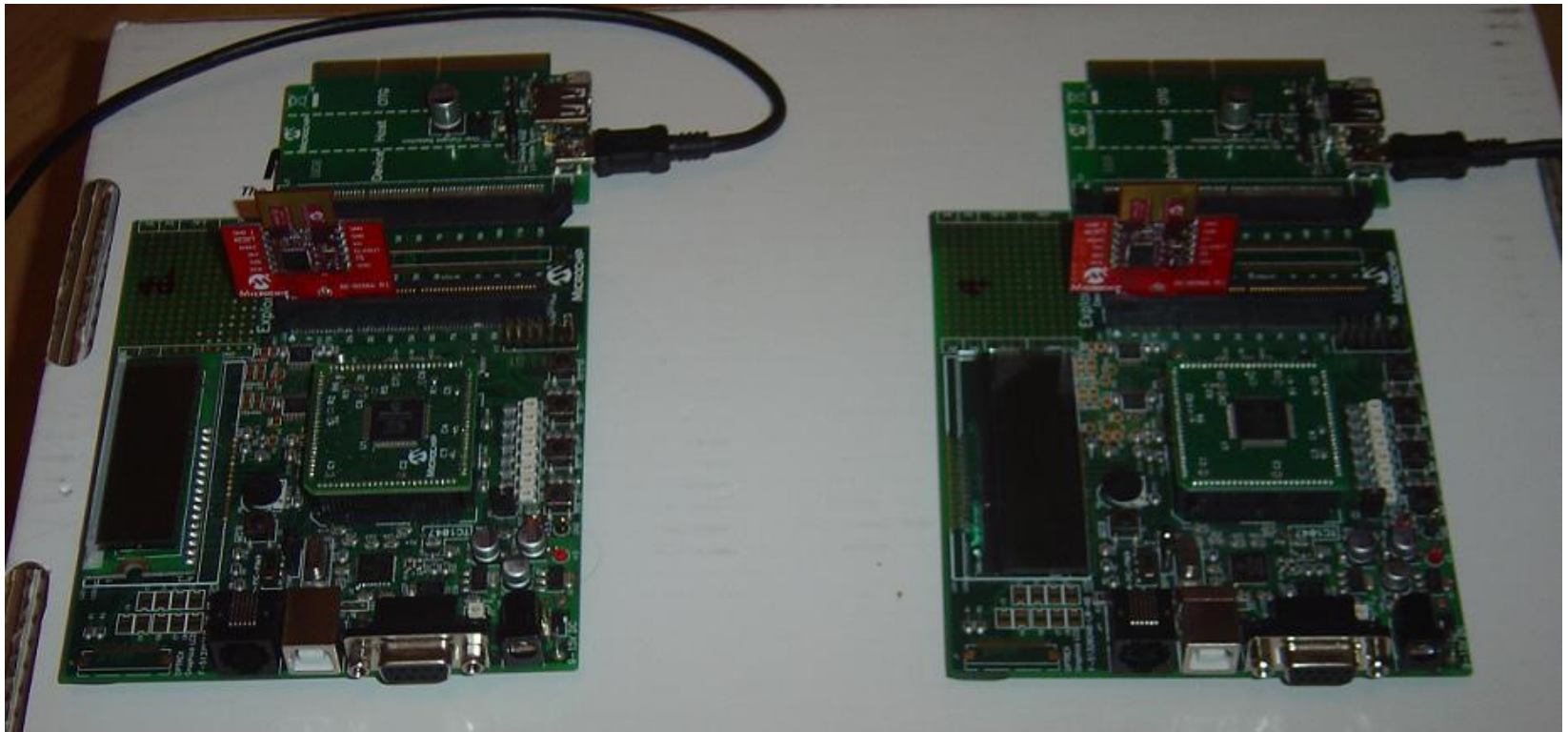
- **USB 2.0 Full Speed**

- **CDC Device Class Used**

- **Opening up a Virtual COM Port**

- **Advantage:**
  - Same software can only be used as with the old RS232 cable
  - Standard Driver like usbser.sys can be used

Miwi P2P

- **Encryption, Decryption 128 Bit AES usable**

- **Different Adress IDs can be used**

- **Broadcasting or Unicasting of Data transfer**

- **Channel Scanning**

- **Etc. ...**

Autorun Demo - Hardware

- **Low Pin Count USB Development Board**

- **PIC18F14K50**

- **Using Internal Flash of the PIC as Storage media**

Block Diagram

PIC

Browser

PIC18

Int. Flash as MSD Device

2 Files:
1) Autorun Script
2) HTM File as Link to the destination

USB

Linked Browser File browses to:

e.g. a Webpage, Online Video, User Manual, Facebook Data, Business Card Data ...

PC

PC opens Flash Drive -> starting Autorun -> Opening up the linked Browser File
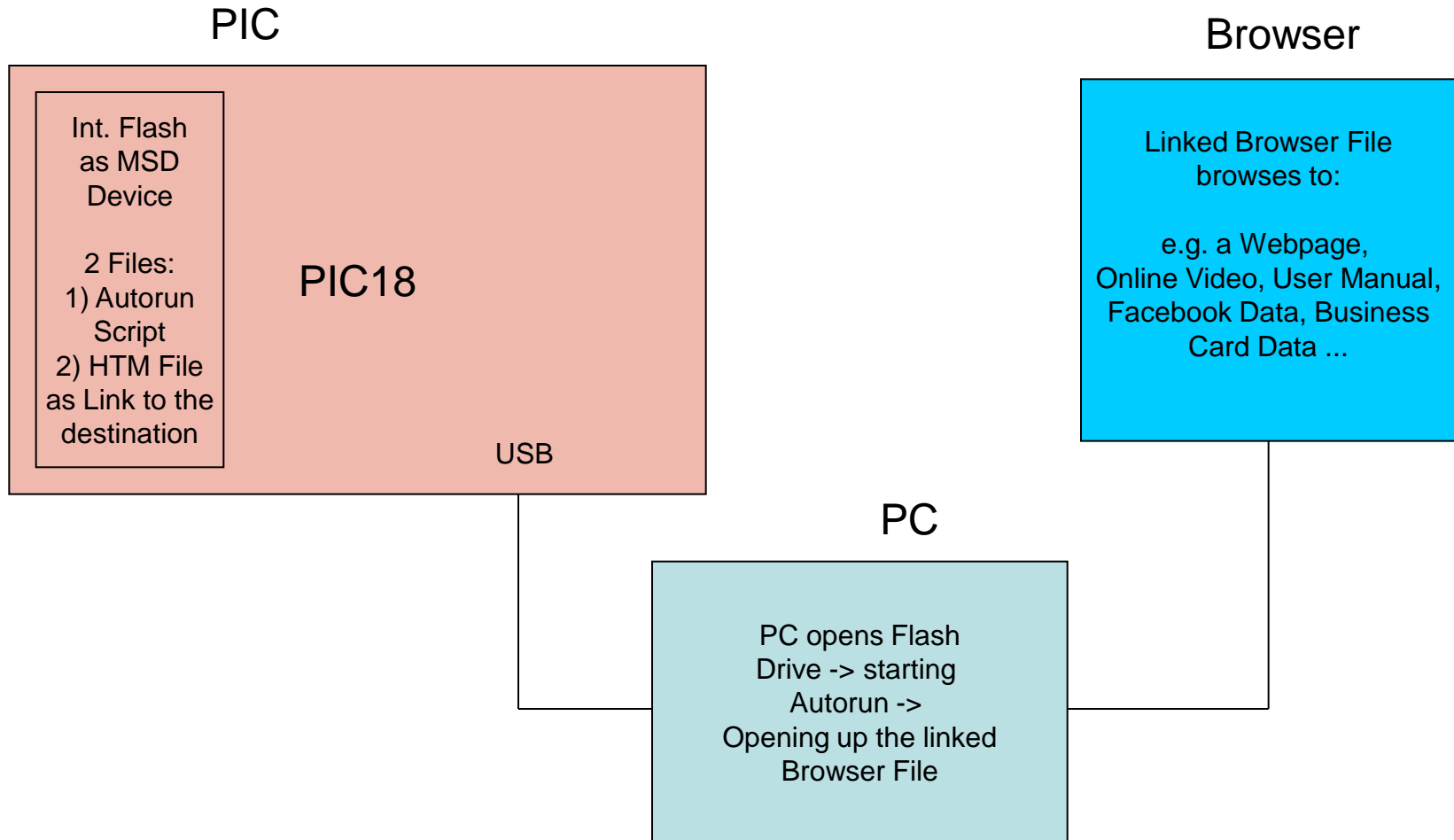
Demo example

- **Demo example reads Autorun.inf**

- **Autorun.inf opens up MCHP.HTM**

- **MCHP.HTM is linked to the USB Homepage from Microchip and pointing to the Webseminar we are offering**

- **Webstream of Video is started automatically via Windows Media Player**

BACK

MSD Host – Thumb Drive

- **The PIC$^®$ can act like a PC, able to manage the contents of a USB Thumbdrive.**

- **The PIC uses a USB Thumb Drive to store temperature data or A/D conversions.**

- **MSD stands for Mass Storage Devices and is a general class used to exchange files.**

MSD Host – Thumb Drive

- **In this demo the PIC32 acts like a computer**
  - You have a terminal to run a PIC$^®$ DOS !
  - You can use PIC DOS commands to manage files on the USB Thumb Drive
  - You can log data in a file

MSD Technical Details

- **No driver needed (built-in to OS)**
- **Bulk transfers mainly**
- **Exchanges based on 3 Bulk transfers**
- **Usually use SCSI commands**
- **Associated to a File System (MDD)**

Demo Block diagram

PIC DOS
>>

+

+

+

MCP2200 USB to RS232 Demo Board
Part Number: MCP2200EV-VCP

USB PICtail Plus Daughter Board
Part Number: AC164131

BACK

The Explorer 16 **100-pin**	Buy DM240001
The Explorer 16 **44-pin**	Buy DM240002
Explorer 16 Starter Kit (with MPLAB ICD 3)	Buy DV164037
Plug-In Modules (PIMs)	

HID Device

- **The PIC$^®$ can act like a keyboard, joystick or mouse**

- **OR you could just use it to transfer data**

- **HID is a general device class for connecting many things to a PC**

HID BootLoader Demo

- **In this demo the PIC18 acts like a bootloader.**

- **This replaces the need for a programmer, since the programmable .hex file can be loaded from a simple PC application, using the USB connection.**

- **PICDEM™ Full Speed USB DM163025**
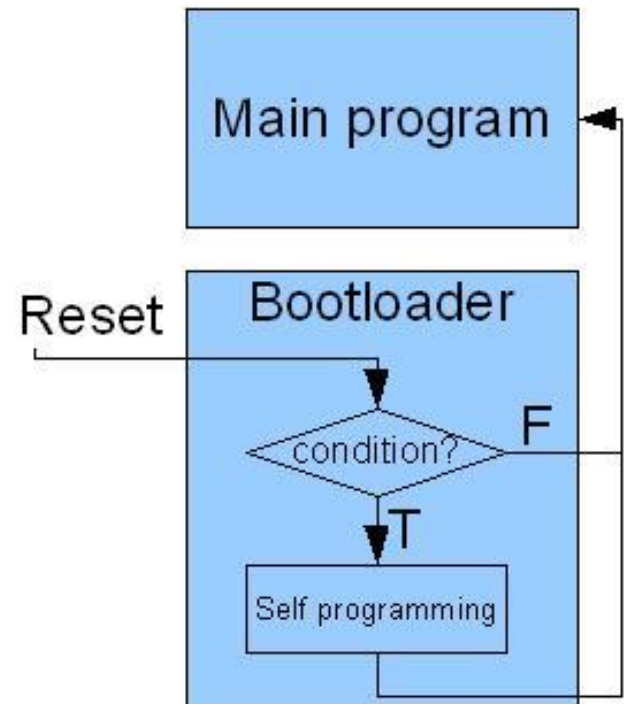
HID Technical Details

- **No driver needed (built-in to OS)**

- **64,000 Bytes/sec transfer limit**

- **Interrupt mode transfers**

- **Descriptor tables**
  - Describe the format of the data

- **Easy to use API calls**
  - HIDTxSend
  - HIDRxReceive

Demo Board Details
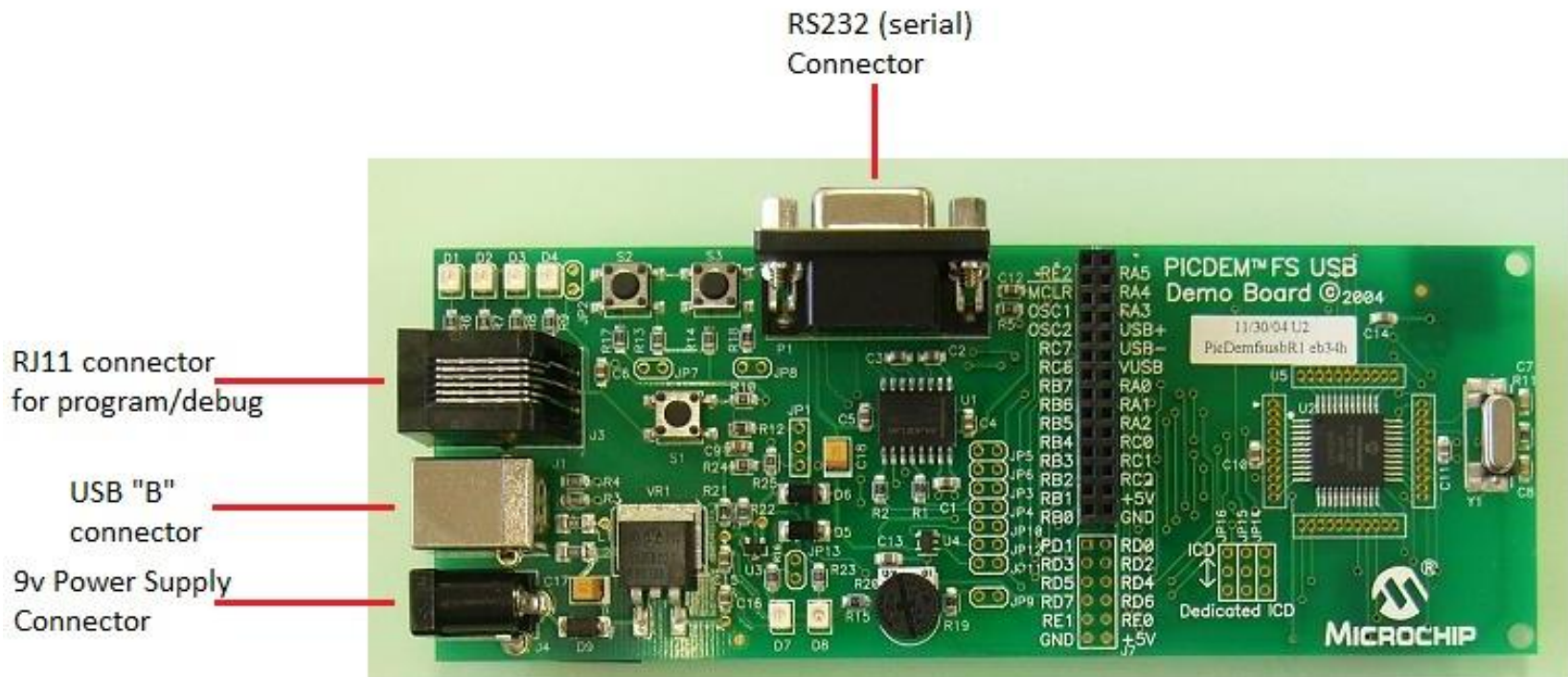
BACK

CDC (Communication Class Device)

- **Focuses on supporting connectivity to:**

    - telecommunication services (devices that have traditionally terminated an analog or digital telephone line)

    - medium speed networking services ("Always Connected" LAN/WAN media types).

CDC – Serial emulator Demo

- **In this demo the PIC18 acts like a USB to UART (RS-232 or "serial") bridge**
  - Using a HyperTerminal window for each of the "COM" ports (one for the USB CDC and the other one for the board's serial connection), the user can send and receive characters both ways.
- **Demo Board: PICDEM™ Full Speed USB DM163025**

Demo Block Diagram

Hyperterminal 1

Hyperterminal 2

UART to USB Adapter

Serial (RS-232)

USB connector

PICDEM™ FS USB
Demo Board © 2004
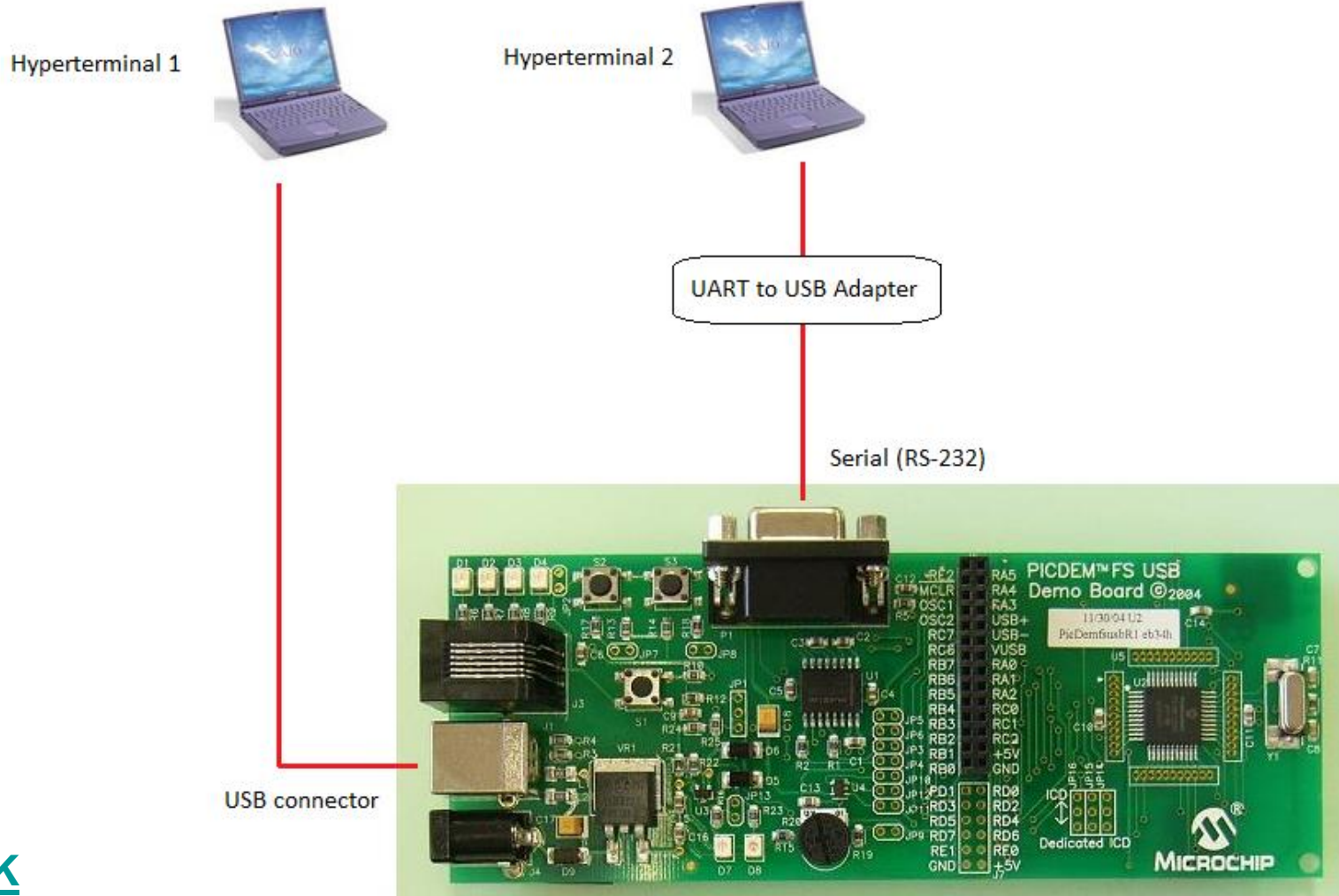
BACK

USB Thumb Drive Bootloader

- **With the Microchip USB stack and filesystem the PIC$^®$ can access data on a Thumbdrive.**

- **This data can be a HEX file that can be programmed into FLASH.**

USB Thumb Drive Bootloader

- **This demo shows how to do a bootloader, that can program and run a HEX file taken from a thumbdrive.**

- **When the PIC® is powered up it will display a screen where you can select one of the HEX files in the thumb drives root.**

Demo Tools
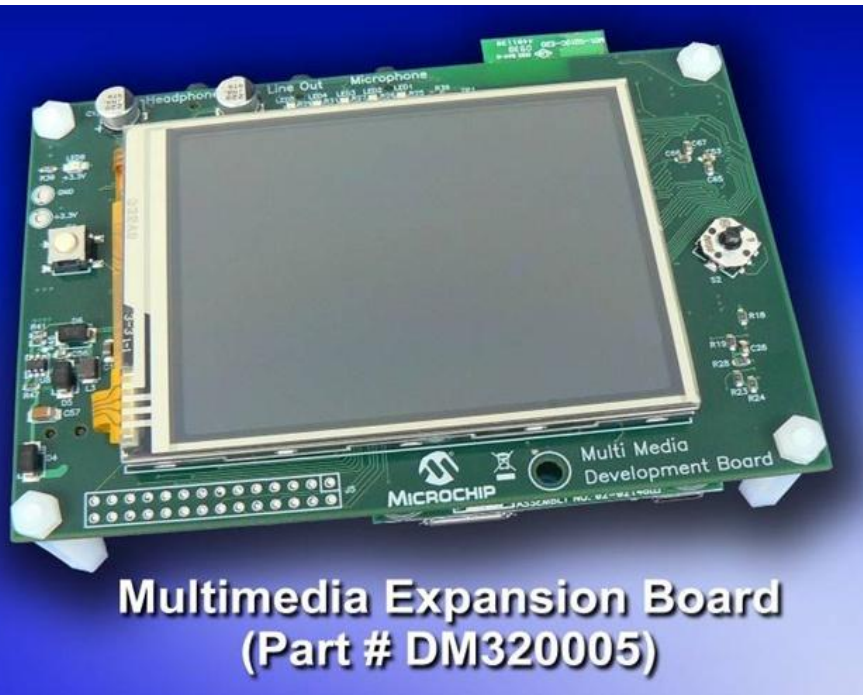
Multimedia Expansion Board
(Part # DM320005)

- **PIC32 USB Starter Kit II DM320003-2**

BACK

MCP2200 Features
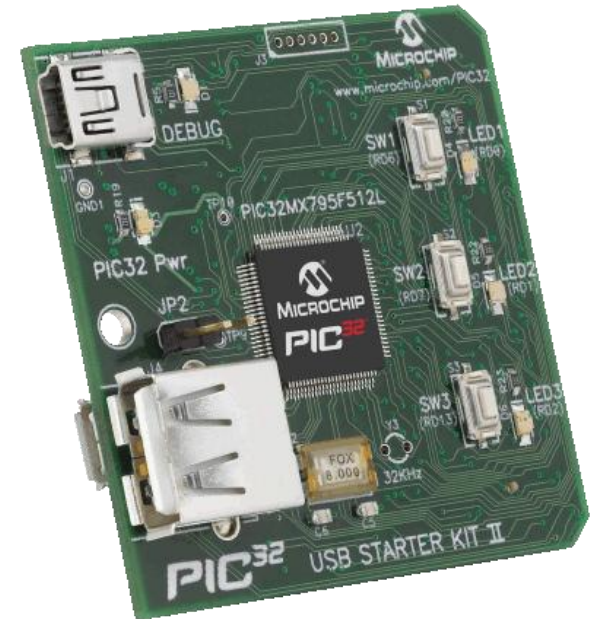
- **USB 2.0 Protocol Converter**
- **Interface**
  - Composite device
    - HID (Configuration only)
    - CDC (Communication only)
  - Supports all UART Baud Rates
    - 300 – 1000k Baud Rate
    - Hardware flow control
    - Provides polarity options

MCP2200 Features

User Options (HID)

- Status pins
  - Bus activity (LED output)
  - Suspend
  - Configuration
- Uses 12MHz external clock
- 8 General Purpose IOs
- 256 bytes of user EEPROM

MCP2200 Features

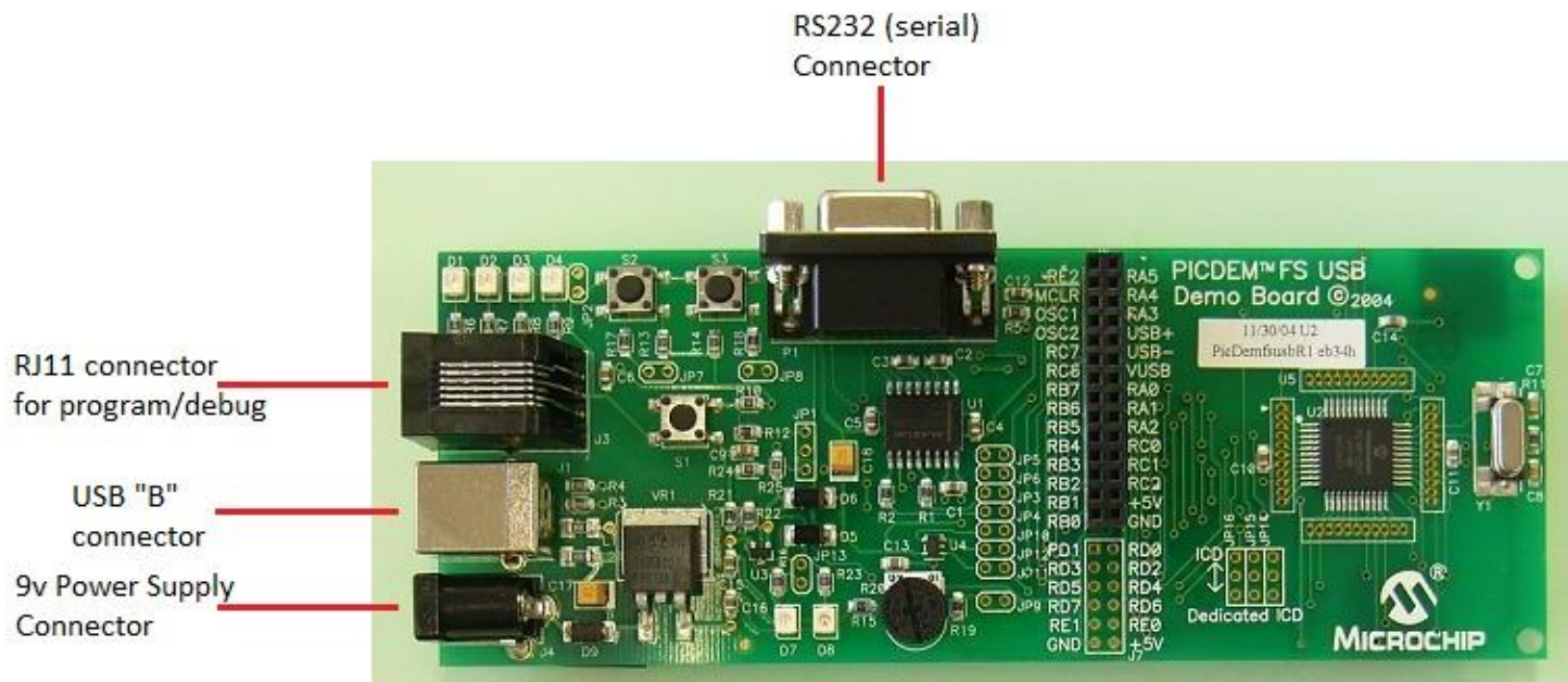# MCP2200 Configuration

MCP2200 Demo

BACK

Custom HID Demo

- **HID is known as interface for data exchange below 64 KByte/s -> typical applications like Mouse, Keyboard, ...**

- **But it can be also used just for data communication**

- **In this demo the PIC18 communicates with the user through a simple PC application, using the USB connection.**

  - The demo board will be seen by the PC as a USB HID, so no drivers have to be installed.

- **PICDEM™ Full Speed USB DM163025**

Demo Board Details

RS232 (serial) Connector

RJ11 connector for program/debug

USB "B" connector

9v Power Supply Connector

PICDEM™ FS USB Demo Board ©2004

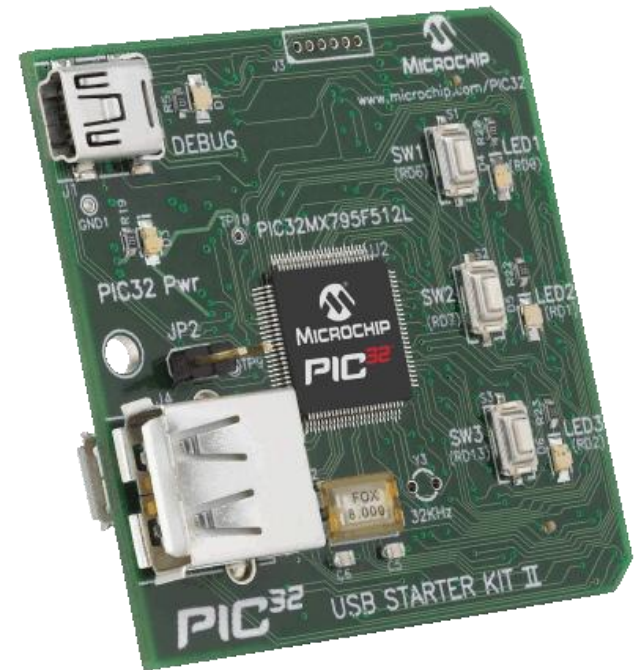**BACK**

High bandwidth transfer

- **For the highest transfer bandwidth use Bulk transfer.**

- **Full speed USB theoretical transfer rate is ~1.2MB/s**

- **Maximum Packet size is 64byte**

WinUSB Driver

- **WinUSB is a vender specific driver produced by Microsoft. This driver allows users to have access to interrupt, bulk, and control transfers directly.**

WinUSB Bulk transfer

- **In this demo the PC sends bulkdata to the PIC32 using WinUSB:**
  - The PC sends 960Kbytes to either one or three endpoints.
  - The transfer rate and elapsed time is displayed

Demo Block diagram
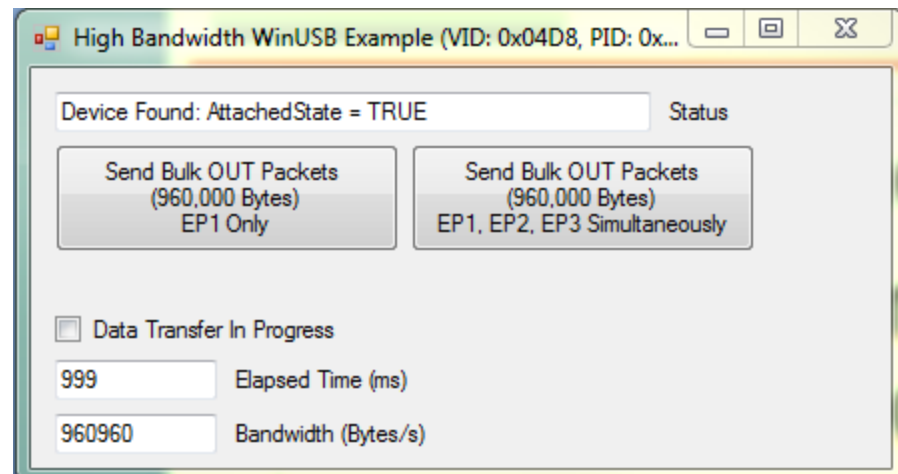
- ## PIC32 USB Starter kit II DM320003-2

Connection for integrated debugger (mini-b)

Embedded Host (std. A)
ideal for USB flash drives

Device, Embedded Host, On-The-Go (micro-AB)

BACK